



## Review

# Human-wildlife conflict and its consequences in Tanzania: advocating the use of One Health approach as a mitigation measure

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## ABSTRACT

Globally, human, livestock, and wildlife interactions have been reported to result in innumerable forms of conflict and consequences. The most notable consequences are on the environment and human health, among others. The least developed countries, Tanzania inclusive, due to their bio-geographical and social characteristics, are mostly reported to register such consequences, which have sometimes led to zoonotic diseases due to the existence of risk factors. The factors include the growth of the human population, absence of infrastructural capacity, and skilled manpower to effectively deal with disease outbreaks and livestock keeping associated lifestyles. This article employs a documentary research method to analyse the human-wildlife conflict (HWC) and its consequences in Tanzania. It further assesses the potential of the One Health approach to curb the consequences of HWC following the introduction of One Health Strategic Plan (2015–2020). This article, therefore, analyses the potential for One Health approach to minimize the undesirable impacts of human, livestock, and wildlife interactions on health. This approach underscores the need for collaborative working efforts involving human, livestock, wildlife, and environmental health professionals and the need for a good understanding of the consequences of the interactions towards the realisation of optimum health for people, animals, and our environment.

## 1. Introduction

Human-wildlife conflict (HWC) has globally been noted, and its history is reported to exist with the emergence of human civilization [1–3]. The literature has reported substantial challenges in biodiversity conservation in areas that have been observed having a direct conflict of wildlife with human [4,5]. Despite the reported unavailability of national or regional statistics on the magnitude of the conflict [6], the scanty existing scientific survey data proves that HWC is escalating across the globe [7–10]. This escalation is tied to innumerable consequences on biodiversity conservation and economic development globally [4,5]. The consequences are connected to human practices/behaviours exhibited by individuals living close to Nature, and these are the areas with livestock holdings and crop fields forming a significant proportion of people's livelihoods [11–14]. These practices have been noted to lead to health impairing outcomes to both humans and animals [14].

## 2. Methodology

This review employed a documentary analysis (documentary research method) to collect information which was relevant to this article. The documentary method connotes a desk review study which allows

researchers to categorize, examine, and interpret written publications; it examines documents comprising information that are relevant to the subject under investigation [15].

The search strategy for this study employed keywords or search terms such as “Human-Wildlife Conflict”, “Human-Wildlife Conflicts Consequences”, “Consequences in Tanzania”, “One Health Approach”, and “how to Advocate the Use of the One Health as Mitigation Measure”. The documents relevant to this review were selected and subjected to quality assessment and data extraction. Documents written in English and reported along with the keywords relevant to this study were included in this study for review. These documents mainly focus on HWCs and One Health, as well as the mitigation potentiality of One Health on HWCs.

## 3. HWC: the what, why and how

Numerous conceptualizations on HWC exist. A study defines HWC as any action by humans or wildlife that has an adverse impact on the other [6]. On the same note, Foreman et al. [16] and Gittleman et al. [17] pointed out that, HWC signifies a growing concern on conservation issues. HWC is a threat that results directly from competition over existing natural resources between the wild animals and rural communities. HWC is likely to be observed when the needs of wildlife conflict with those of

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humans, resulting in costs to both conservation efforts and local communities [18].

Human-wildlife conflict exists in countless contexts, though numerous studies have concentrated on rural parts of the least developed countries (LDCs) [4,19,20]. This, however, doesn't affirm the fact that HWC only exists in the LDCs. For example, the conflict is also experienced in North America [21,22], Europe [23], Australia [24] and Asia [25]. Due to their bio-geographical and social characteristics, LDCs particularly, seem to be vulnerable to this problem and are frequently reported to experience its consequences [26].

Generally, several factors, including demographic trends, contribute to escalating HWC [27]. For example, human population has always been increasing while the resources available are finite. In this case, HWC is reported to intensify in areas where significant proportions of human populations are residing in proximity to Nature, and where crop fields and livestock holdings are observed to form a substantial proportion of rural livelihoods. Notably, with the increase of the population, there is a significant growing demand for resources and space, leading to human expansion into wildlife habitats and the displacement of natural wildlife territories [2,28]. As a result, agricultural growth has pressed wildlife into smaller and split spaces [28]. It is in this context that Benjamin-Fink [3] reports the incidences of both humans and wildlife suffering from noticeable consequences, hence a need for stakeholder engagement and their readiness to embrace conservation-based behaviours as fundamental components of possible and effective conservation strategies.

#### 4. Trends and consequences of HWC on wildlife conservation and socio-economic development

It is very clear that governments all over the world have been struggling to minimize the interactions between humans and wildlife by imposing numerous restrictions or otherwise thinking about the best ways such interactions could continue while the consequences are minimized. The main observation is that the restrictions imposed have not always translated into success. This tells that HWC in some ways cannot be eliminated since the interactions have both positive and negative impacts, but rather the consequences can be mitigated.

A study has observed the development of negative attitudes with respect to wildlife-protected areas, wildlife and conservation in general [28]. Numerous perspectives are attached to this negative attitude. Some have developed this attitude based on the destruction experienced on their crops by wild animals; some held the negative attitude simply because of the fact that they felt denied access to certain resources found in the protected areas, e.g. firewood, wild fruits, etc.; for others, it is those health-related negative consequences that have made them develop negative attitudes.

There are countless incidences in various parts of northern Tanzania where wildlife has been reported to undermine livelihoods for humans and threaten their lives at the household level, and vice versa [29–31]. The problem becomes extremely serious for communities residing near protected areas. In such areas, for example, the expansion of cultivation by smallholder farmers in dispersal areas has been observed to reduce animal home ranges, further intensifying HWC. Similar challenges have also been observed in areas around national parks.

It is reported that summary statistics at national or state levels are often unavailable with regard to the scope of destruction or economic and social losses which have been caused by wildlife on the property, lives of humans, and opportunity costs [6]. This is simply because the extent of the destruction to each category caused by various wildlife species has in most cases remained speculative.

It is extensively held that larger herbivores and carnivores are the ones responsible for a lot of the HWC in Tanzania [32]. Costs incurred by local community from wildlife conservation include crop destruction, injuries to humans and/or deaths by African savannah elephant (*Loxodonta africana*), crop destruction by other large herbivores such as African buffalo (*Syncerus caffer*) and common hippopotamus (*Hippopotamus*

*amphibius*). Livestock depredation is known to be carried out by large carnivores like lion (*Panthera leo*), leopard (*Panthera pardus*) and cheetah (*Acinonyx jubatus*). It should be noted that the communities affected by carnivores have consistently borne the indirect costs of preventing attacks on human and livestock lives, living in constant fear [33].

The main form of HWC observed in regions near protected areas, Selous Game Reserve inclusive, has comprised crop-raiding. On average on a yearly basis, hundreds of acres are destroyed by crop-raiding by African savannah elephant, common hippopotamus, bush pig (*Potamochoerus larvatus*), and vermin primates including olive baboon (*Papio anubis*) and vervet monkey (*Chlorocebus pygerythrus*), and other different mammals [34]. At the Jozani Forest Reserve in Zanzibar, Siex et al. [35] identified a case of HWC whereby the villagers declared incidences of red colobus (*Piliocolobus kirkii*) consuming coconut (*Cocos nucifera*).

It should not be however misunderstood that small animals are not responsible for the conflict. Vertebrate pests like monkeys, baboons and rodents (e.g. rats and mice) normally get into conflict with farming undertakings. In a study, food insecurity was identified as a result of substantial pre- and post-harvest damage to crops, and sizeable economic losses including the destruction of electric and other installations being the effects brought about by small mammals, particularly rodents [36]. For example, a population outbreak of Natal multimammate mouse (*Mastomys natalensis*) has been associated with increased food loss (up to 80 %), therefore, food insecurity in rural areas of Tanzania such as Berega village in Kilosa District is a case example [37].

On several counts, the local communities have been reported to kill wildlife to satisfy their dietary needs including bush meat for household consumption, and sometimes even for the sake of trading to generate income as well as killing in retaliation by poisoning [30]. According to a report, Tanzania had retained only 43 % of its original wildlife habitat by 1986, with much of the land converted for other uses [38]. During this period, the country also recorded a decline in elephant populations in the Ruaha-Rungwa and Selous-Mikumi ecosystems. This decline was largely attributed to poaching, driven by increased international trade and rising demand for ivory. The fluctuations in elephant populations highlight several factors associated with HWC. Based on what has been observed from biological hot spots due to the growth of human populations, modern development projects and the subsequent competition for resources with wildlife, notable incidences of destruction to the environment, degradation and fragmentation have been registered [39].

The society plays a critical role by sharing their views with the professionals on the conflict and ways to mitigate different forms of the conflict. Community views and opinions are vital in wildlife management and planning. Community attitudes toward wildlife should be consistently regarded as a crucial factor in developing effective management strategies [40,41].

#### 5. Health related behaviours and practices in the convergence of humans, animals, and the environment

Communities living close to protected areas, in pursuit of their livelihoods find themselves constantly interacting with wildlife, consequently involving themselves in certain practices or behaviours which in turn negatively influence the state of their health. Human practices such as killing wildlife to get bush meat for household consumption, sometimes have resulted in the exchange of diseases between livestock and wildlife [30,42,43]. In an effort to alleviate the situation, Tanzania legalized bushmeat trading through Government Notice No. 84, published on 7 February 2020, which was very logical given that the use of game meat is rooted in a complex cultural, political and economic context with specific drivers and mechanisms that are societal in nature. The move was equally viewed to lessen the unprecedented poaching of game meat in wildlife-protected areas [44,45] associated with the ever-growing human population in the face of limited supply of the resources hence food insecurity. Such initiative, despite having been observed to have that potential, if not properly supervised and

monitored, may further accelerate the spread of zoonoses. These incidents have been significantly reported among other areas including in some parts of Tanzania such as Iringa, Singida, Kondoa, Rombo, Hai, Arumeru, Mbulu and Same Districts, which have been a threat to public health [46].

A study has identified several health behaviours and practices that are reflected in the animal–human–environment interface through literature review [14]. These practices/behaviours are summarized in Table 1. The practices are categorized into four areas: (1) eating habits, food preparation and consumption, (2) animal handling, (3) the interaction between animals and humans, and (4) unhealthy living and lifestyle.

The practices/behaviours presented in Table 1 reflect important health aspects beyond human health as they cut across health in the convergence of humans, animals, and the environment. In this context, evidently attaining optimal health calls for multi-disciplinary collaboration along with understanding the consequences of the interactions on health. A close look at the practices points out numerous challenges if effective modalities and interventions to suitably improve livelihoods and wildlife sustenance are to be devised. The picture is very clear that a joint effort involving human, animal, and environmental health professionals is inevitable to offset such situations.

## 6. Consequences and intensity of human–livestock–wildlife interactions on health

It is obvious that good health is a cornerstone of development in all societies [14,47–53]. This is because the health status of society can affect all other sectors in that particular society, i.e. politics, social, and economic aspects [54]. In particular, human capital is a key driver of economic development [48,50,55] since good health boosts labour productivity, educational achievement and income hence lessening poverty [56]. In other words, diseases and poor health are considered as obstructions to economic growth and ultimately, to national development on a global scale [56, 57].

Apparently, achieving a development goal requires significant enhancement in the health status of the population in a respective nation; however, it is evident that several challenges exist towards the attainment of good health [58,59]. Innumerable studies have reported HWC to

be associated with zoonoses, which stands as one of the challenges in gaining good health [5,60–62]. Obviously, disease transmission, if left unattended, will impact negatively on human and livestock health.

However, the impacts of zoonoses are disproportionately high in LDCs and still remain a major concern globally. Several risk factors contribute to this heightened impact in LDCs, including but not limited to the high growth rate of population, a lack of skilled manpower, and inadequate infrastructure to deal with diseases outbreaks. Additionally, lifestyle factors play a role, particularly in communities that rely heavily on wildlife resources, including animals, for their daily needs [61]. It has been observed that eastern and southern African countries, including Tanzania, have large populations of livestock, human and wildlife populations living in close proximity and sharing ecosystem services such as land, water and fauna resources. As these animals interact, the likelihood pathogens transmission increases, which can lead to outbreaks of zoonotic diseases in these populations.

Regrettably, the transmission of zoonotic diseases continues to be an issue in areas with coexistence of pastoralism and agro-pastoralism activities. A case at hand is the Selela Wildlife Corridor, which links Lake Manyara National Park and Ngorongoro Conservation Area. The key concern in this area has remained to be transmission of diseases [63]. Additionally, a study at Arusha National Park identified disease transmission to both livestock and humans as one of the wildlife-related problems for local communities [43]. It is important to note that predators and scavengers, such as the African wild dogs (*Lycaon pictus*), lions, jackals (*Canis aureus*), vultures (*Accipitridae/Cathartidae*), and spotted hyenas (*Crocuta crocuta*), contribute to the spread of pathogens through dismembering, opening, and dispersing infected carcasses.

Illegal bush meat hunting and trade have been reported to be associated with the spread of zoonotic diseases in villages neighbouring western Nyerere National Park in southern Tanzania [64]. Similarly, cases have been reported at the human–livestock–wildlife interfaces with respect to disease transmissions in other parts of the country including northern Tanzania [48,65]. The diseases include human brucellosis and rabies originating from both traditional (kept for their labour, meat, hides, and other by-products) and dairy animals (kept for milk production and dairy products). A report by International Livestock Research Institute (ILRI) as cited by Grace et al. [66] has identified zoonoses as obstacles to poverty alleviation, affecting a significant number of livestock keepers.

HWC has the potential to lead to poor health and diseases if serious interventions are not put in place. Interventions will be effective and optimal health achieved if they are based on the recognition that the health of the people, animals and the environment are inextricably linked [11–13]. Therefore, One Health in Tanzania is considered to be critical in reducing the impacts of HWC on humans, animals, and environmental health. The health-related consequences can be substantially minimized by advocating the One Health approach as the most potent approach to lessen the negative effects of the interactions.

## 7. One Health approach as an intervention

### 7.1. One Health approach: concept and practices

One Health approach is a modern global movement aiming at promoting collaborative efforts between different health-related professionals (medical doctors and veterinarians) and other scientific, environmental and related disciplines. The American Veterinary Medical Association (AVMA) defined One Health as the “collaborative effort of multiple disciplines working locally, nationally and globally [67]. The approach recognizes that various disciplines cutting across numerous sectors are likely to provide solutions to the complicated problems confronting public health”. A literature points out that this holistic approach gives emphasis to multi-sector and trans-disciplinary action across professions to warrant well-being within human, animal and ecosystem interfaces [68].

**Table 1**

Summary of health impairing behaviours in the context of human–wildlife conflict.

No.	Category	HIBs
1	Eating habits, food preparation and consumption	a) Consumption of game meat without veterinary clearance; b) Preparing meat from naturally dead animals; c) Consuming raw blood or meat (or undercooked meat) and non-boiled milk; d) Failure to inspect meat before being turned into the market
2	Animal handling	a) Touching infected game meat i.e. anthrax-infected hippotamus meat; b) Handling wildlife trophies without veterinary clearance; c) Failure to wash hands after handling animals; d) Failure to wear a face mask when attending an animal suffering from respiratory disease
3	Interaction between animals and humans	Interaction between wild animals and livestock a) Livestock sharing water sources with wildlife; b) Cattle interaction with the wild animals in the grazing areas; Interaction of animals and humans a) Use of shared water sources between wildlife and humans; b) Sharing houses with livestock
4	Unhealthy living and lifestyles	a) Reluctance to destroy carcasses not fit for human consumption; b) Purchasing meat from unreliable outlets (no guaranteed meat inspection)

The efforts to control the transmission of infections between animals and humans face numerous challenges, the absence of or limited integration across professions being the most. Thus, the need for joint action with a combination of technologies and collaboration between both medical and veterinary professionals is paramount [69]. It is revealed that zoonotic diseases are reported to have incurred a direct cost of over 20 billion U.S. dollars over the last decade while the indirect losses to affected economies are reported to exceed 200 billion U.S. dollars in total [51]. It is further reported that 70 % of the rural poor's livelihoods globally rely on livestock [70]. Given this situation, animals cannot be excluded from the solution strategy. Zoonoses control is unique in that effective interventions may lie outside the health sector, as transmission frequently occur from animals to humans rather than between humans, as seen in diseases like rabies or brucellosis [71].

### 7.2. Benefits and rationale of One Health

According to AVMA [67], the One Health approach has several benefits including:

- i) improving animal and human health globally through collaboration among all the health sciences, especially between the veterinary and human medical professions to address critical needs;
- ii) meeting new global challenges head-on through collaboration among multiple professions—veterinary medicine, human medicine, and environmental, wildlife and public health;
- iii) developing centres of excellence for education and training in specific areas through enhanced collaboration among colleges and schools of veterinary medicine, human medicine and public health;
- iv) increasing professional opportunities for veterinarians; and
- v) adding to our scientific knowledge to create innovative programs to improve health.

One Health competencies have the potential to contribute to the development of skills towards effective and efficient collaboration among disciplines for solving shared health challenges; including food and nutrition security. It is vivid that food and nutrition security stand a good chance of improving the health status of the population, which is a very vital parameter towards national development. The skills targeted here comprise sharing of knowledge, information and data strengthening the relationships and interdependencies between human health and other health-related disciplines such as social sciences, animal health and ecosystem health.

### 7.3. One Health approach: where are we?

The increasing dependence of humans on what is produced by animals has prompted the medical and veterinarian professions to promote the need for a holistic, collaborative approach. This approach encourages local, national, and global joint efforts involving multiple disciplines to work together for optimal health [67,71]. Therefore, the government of Tanzania, on 13 February 2018, inaugurated the “One Health Coordination Desk and the National One Health Strategic Plan”. This signifies an essential landmark towards dealing with health-related challenges reflected in the convergence of humans, animals and the environment. This particular landmark highlights the commitment of the government to reinforce mechanisms towards the detection of outbreaks, prevention and responses. The milestone is outstanding in the sense that it leads to the building of fundamental capacities concerning public health events particularly when it comes to preparedness and response as per International Health Regulations. This step is cognizant of the fact that over 60 % of emerging, re-emerging and endemic human diseases are originating from animals. Now more than ever, humans are at a higher risk of contracting diseases that originate from animals. This situation is amplified by an extensive range of interconnected variables, comprising large-scale livestock production, mass urbanization and increased travel.

Using the One Health approach, the government of Tanzania made countless efforts to identify zoonotic diseases of utmost national concern. In this task, representatives of livestock, human health, wildlife, agriculture, research, higher education and environment sectors availed their inputs. A tool named One Health Zoonotic Disease Prioritization (OHZDP) was prepared for the identification of Tanzania's priority zoonotic diseases. Through this exercise, a total of six zoonotic diseases of the highest priority to Tanzania were identified using the criteria for prioritization. The identified diseases are to be used to advocate for and build capacities in numerous areas including surveillance and laboratory detection systems, improving prevention and control across the key One Health sectors in the country [11].

According to the Centers for Disease Control and Prevention (CDC) [11], national representatives made zoonotic disease prioritization the first step for addressing public health challenges emanating from zoonotic disease threats. This was followed by a training organized by CDC for nine local partners from the animal, human and environmental health sectors. The training was meant to create an in-country capacity to facilitate future One Health prioritization workshops. The in-country facilitator training was conducted on 20–22 March 2017. The workshop on OHZDP employed a multi-sectoral One Health approach in prioritizing endemic and emerging zoonotic diseases of public health and animal health concern. The target is on the diseases that may be jointly addressed using an inter-ministerial partnership.

Though One Health is at its early stages in various parts of the world, there is notable potentiality in addressing the wildlife–human–livestock boundary diseases by employing trans-disciplinary teams, which will broaden the scope of options for solutions. It is evident that achieving optimal health requires collective efforts between professionals. This has to go hand in hand with a thorough understanding of the interactions and their consequences on health [12,13,52,67,71].

It should however be noted that for One Health measures to effectively mitigate the consequences of HWCs, there is a need for further investment in interventions that are targeting at the creation of collaborative working relationships involving the humans, animals, environmentalists as well as agriculturalists. This investment is necessary as had proven that both knowledge and awareness on the concept and practices related to One Health was very low [52].

### 7.4. Humans, animals and the environment—the interconnections

Incidences of HWCs are increasingly reported as rising population density forces humans to occupy diminishing land resources. The convergence of humans, animals and the environment has resulted in a complex interface in which the health of each group is inextricably interconnected. Definitely, the challenges linked to this intersection are significant, complex and unprecedented. For example, the need for animal-based protein was projected to increase by 50 % by 2020, placing intensified pressure on animal populations and contributing to a notable loss of biodiversity [67].

However, it has been reported that out of 1461 incidences of diseases found in humans, nearly 60 % were caused by multi-host pathogens that move across species lines [72]. Consequently, it was estimated by AVMA that over the last three decades, zoonotic diseases may have accounted for roughly 75 % of newly emerging human infectious diseases [67]. The increasing human dependence on animals and their products is considered the most serious risk factor to human health and well-being concerning infectious diseases.

There is an intensifying worry that the world's latest generation will be the first in history to face a decline in life expectancy and health in general. Despite that worry, currently, veterinary and human medicines are regarded as isolated entities, and it is even worse when the apparent links between these disciplines are often neglected. It has been observed that the traditional approaches, levels of knowledge, and past obligatory skills may not be conforming to the fast changes, new demands of food-animal industries and the shifting requirements desirable for the corporate and public opportunities in the future [67].



Simultaneously, contamination and pollution have significantly compromised environmental health and sustainability. Environmental degradation encourages the increase of infectious diseases and non-infectious threats. In events of environmental degradation, it is anticipated that favourable settings for the growth of existing infectious diseases will be created along with an obvious increase in acute and chronic non-infectious diseases harmful to both animal and human health. Non-infectious threats include toxins and chemical contaminants in the environment, particularly endocrine-disrupting chemicals [73]. Examples of such contaminants include fire-retardant chemicals in carpets which have been linked to adverse effects in pet cats, the melamine contamination of pet foods, and marine toxins in manatees [74]. Environmental conditions are also closely tied to the transmission of diseases such as malaria. Effective environmental management practices, such as draining stagnant water and eliminating mosquito breeding sites, have the potential to reduce malaria transmission when implemented at the community level [75].

The One Health concept provides a comprehensive framework for understanding the interconnectedness of human, animal, and environmental health. By promoting interdisciplinary collaboration, One Health offers a strategic approach to addressing complex health challenges emerging from these interactions.

## 8. Conclusion and recommendations

Increasing pressures are emerging at the borders of national parks and other wildlife-protected areas worldwide. Addressing the effects of human-wildlife interactions requires the development and implementation of new strategies to manage these challenges effectively. The major negative consequence of the interaction is the impact on humans, animals and environmental health. In this context, adopting a multi-disciplinary approach is essential for developing effective solutions towards these health-related challenges. One Health approach has proven to be a suitable strategy to address such challenges. Given that human-wildlife interactions cannot be entirely discouraged due to their economic and societal benefits, efforts should focus on minimizing the associated health risks. Consequently, scaling up the adoption of One Health practices should be considered a priority.

## Ethics approval and consent to participate

Not applicable.

## Consent for publication

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**Mikidadi Muhanga:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization.

## Declaration of competing interest

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